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“RE-AFFIRMED 1995”

IS: 6522 - 1972

(Reaffirmed 2004)

Indian Standard

CRITERIA FOR DESIGN OF SILT VANES FOR SEDIMENT CONTROL IN OFFTAKING CANALS

(Second Reprint FEBRUARY 1989.)

UDC 627.886

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Indian Standard

CRITERIA FOR DESIGN OF SILT VANES FOR SEDIMENT CONTROL IN OFFTAKING CANALS

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CRITERIA FOR DESIGN OF SILT VANES FOR SEDIMENT CONTROL IN OFFTAKING CANALS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 February 1972, after the draft finalized by the Canals and Canal Linings Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 The total sediment load carried in a channel flow can be divided into two parts; the bed load consisting of sediment particles essentially in contact with the bed and the suspended load consisting of sediment particles in suspension. The concentration of sediment in suspension is much greater near the bed than in the upper layers. The grade of these particles is coarser at the bottom than at the upper layers of water. Also, the upper layers in the main canal have considerably higher velocities than the lower layers and have, therefore, considerably more momentum and consequently the bottom layers containing heavy sediment are deflected more easily from their course and can be drawn away from the offtaking canal more readily. As such if the bottom layers of flow are diverted without disturbing the natural distribution of sediment load, a large quantity of coarser sediment can be prevented from entering an offtaking canal.

0.3 Whereas the exclusion of the sediment load in the canal itself is achieved by providing silt ejector at suitable location, control of entry of sediment at the head of offtaking canal from a main canal is easily effected by providing skimming platforms and silt vanes. Silt vanes are one of the efficient devices to exclude or adjust entry of silt into an offtaking canal.

0.4 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers criteria for design of silt vanes for sediment control in offtaking canals.

NOTE 1 — The silt vanes are silt exclusion devices at the head of an offtake. However, once excessive silt has entered an offtake, sediment ejector has to be used which is covered under IS : 6004-1971*.

NOTE 2 — Silt vanes are also called as King's vanes.

2. MATERIAL

2.1 Silt vanes shall preferably be made of plain or reinforced concrete conforming to IS : 456-1964†.

3. DIMENSIONS AND SHAPE OF VANES

3.1 A typical design and directions for layout of silt vanes is given in Fig. 1.

3.2 Radii of Vanes — The curvature of vanes should be smooth and regular so that there is no churning action over vanes and there is minimum obstruction to the flow for preventing the silt from jumping over them. Radius larger than 12 m should be aimed at for the shortest vane but it shall not be less than 7.5 m in any case. The minimum possible radius depends upon the velocity and as such low vanes which only control bottom water with a low velocity may have smaller radius as compared to high ones. The greater the radius the more efficient will be the vane.

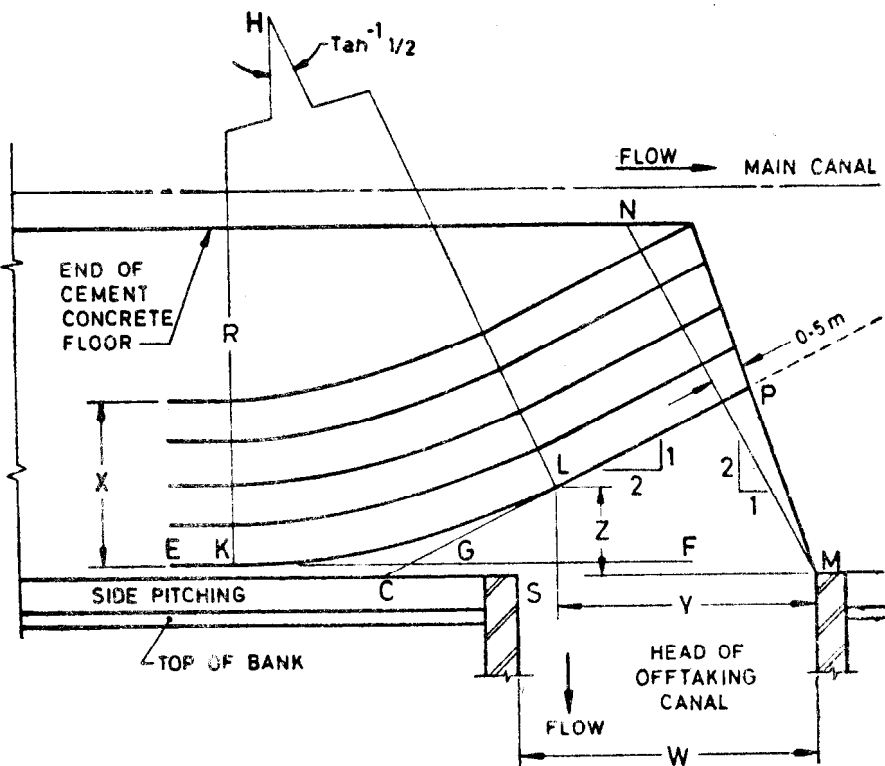
3.2.1 The recommended dimensions for various widths of offtaking canal is given in Table 1. These dimensions are intended only as a rough guide. The radii would also depend upon the proportion of discharge of the offtaking canal in relation to the parent canal and the canal widths.

NOTE — The same recommended dimensions may be adopted in the case of skew offtakes also.

3.3 Upstream Ends — The curved vanes shall be preceded by a straight length parallel to the centre line of the parent canal and finished to a V-shape. The straight portion shall have a slope of 1 vertical to 3 horizontal and a cut water shape at the upstream end. This shape is essential for preventing collection of grass or other debris on the vane which leads to creation of eddies. The upstream end of the curved vanes beyond the sloping nose shall be tangential to a line parallel to the centre line of the parent canal. Plan and elevation of the upstream end of vanes is given in Fig. 2A.

*Criteria for hydraulic design of sediment ejector for irrigation and power channels.

†Code of practice for plain and reinforced concrete (second revision).

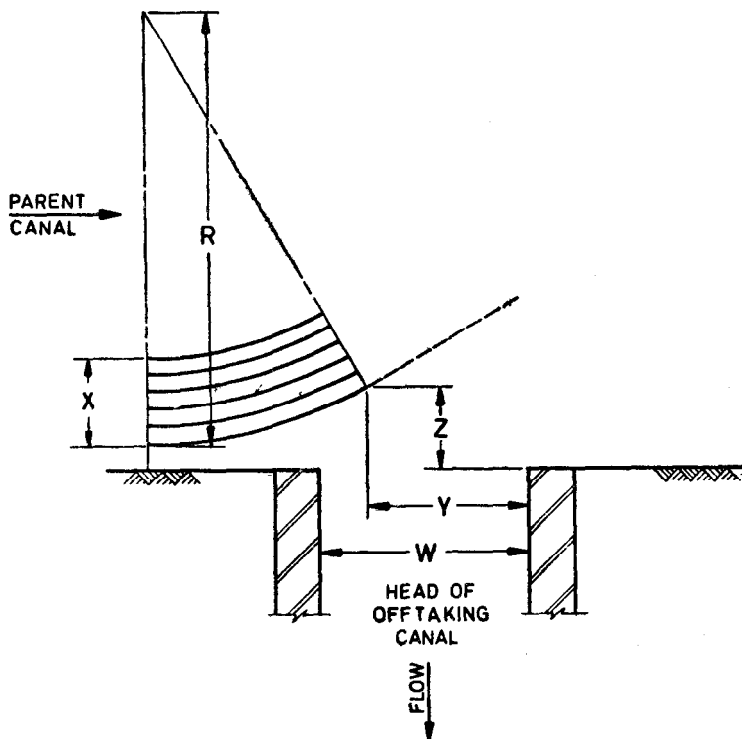


DIRECTIONS FOR LAYING OUT

1. From the face of the off-taking head, draw a line SL at right angles to the centre line of parent canal and at a distance Y from the downstream edge of the off-taking canal of the lengths specified as in Table 1. Through the point L draw a line LC at an angle of 2 to 1 with the centre line of the parent canal cutting the edge of the parent canal at C upstream of off-taking head.
2. Locate the points K and G on lines EF and LC respectively such that $KG = GL = (\sqrt{5}-2) R$. Draw perpendiculars to lines EF and CL at K and L respectively. These two perpendiculars will intersect at centre H .
3. The curves should end at the lines HK and HL .
4. From the downstream edge of the off-taking head draw a line MN in a direction upstream from M and at a slope of 2 to 1 as shown with the centre line of the parent canal.
5. From L lay off a distance LP along the line CL such as to project 0.5 metres beyond the line MN . Then $EKLP$ is the position of the longest vane.

FIG. 1 TYPE DESIGN FOR SILT VANES

TABLE 1 DIMENSIONS OF SILT VANES
(Clauses 3.2.1, 3.6 and 3.7)



Width of offtaking canal = W in m	0.60	1.2	1.8	2.4	3.0	3.6	4.6	6.0	7.6	9.0	10.6	12.0
Value of X in m	1.2	1.5	2.1	2.4	3.0	3.6	4.6	5.4	6.0	7.0	7.8	8.5
Value of Y in m	0.6	1.2	1.5	1.8	2.4	2.7	3.0	4.0	5.2	6.0	6.6	7.6
Value of Z in m	1.2	1.2	1.5	1.8	2.4	2.7	3.0	3.6	4.2	5.2	5.8	6.6
Value of R in m	9.0	9.0	10.0	12.0	18.0	21.0	24.0	30.0	35.0	44.0	50.0	57.0

NOTE — The above values are only intended as a rough guide and should be varied according to the circumstances of each case. For example, R should be greater for a large parent canal than for a small one. Also X and Y would ordinarily be made larger for a large and deep parent canal than for a small one.

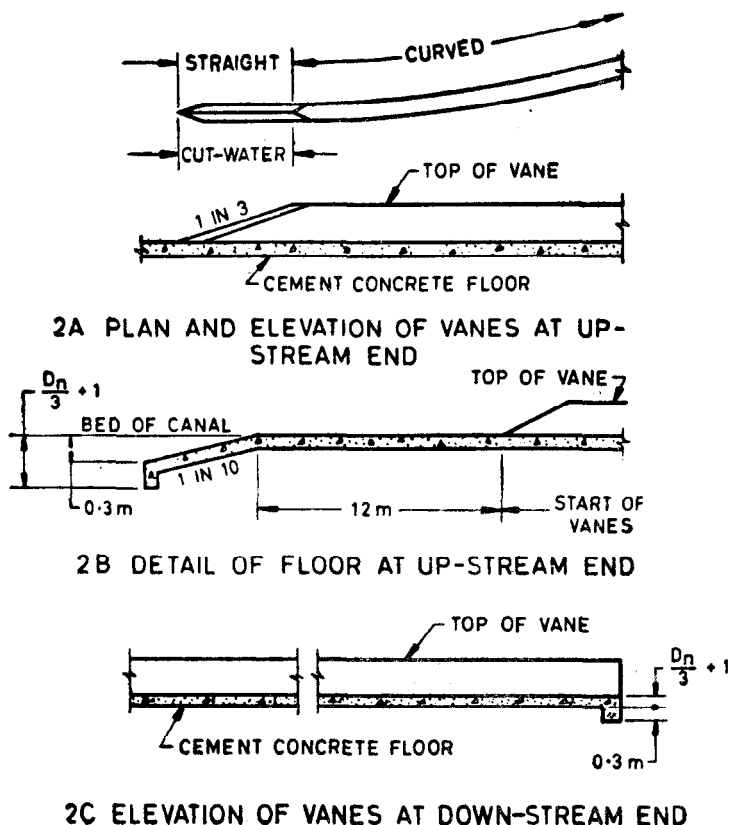


FIG. 2 VANES AND FLOORING DETAILS

3.3.1 Because of draw of bed load sediments due to introduction of vanes, there would be some scouring at the upstream end of floor. It is preferable to depress the floor, a little, provide a curtain wall and meet the horizontal floor at bed level in 1 in 10 slope. The details are shown in Fig. 2B.

3.4 Extent of Curve — The downstream ends of the curved portion of the vanes shall be tangential to lines which are at an angle not less acute than 2 to 1 (about 27°) with the centre line of the parent canal.

3.5 Position of Downstream End—A line is drawn from the downstream edge of the offtake in the upstream direction at an angle of 1 in 2 with the centre line of the parent canal.

The longest vane shall not fall short of this line. Preferably it should extend up to a point (say 0.5 m) beyond this point as a precautionary measure. If the curved portion of vane falls short of this line the vane shall be extended tangentially to the required extend. An elevation of the vanes at the downstream end is given in Fig. 2C.

3.6 Position of the Longest Vane—The distance shown as $\angle$ in the figure in Table 1 may vary from 1.2 m in the case of very small offtakes to 6.6 m for channels of 12 m bed width according to Table 1.

NOTE—If the vane nearest to the offtaking canal (which will be the longest vane) is situated so that some point on it is very near the offtake the water above the vane at that point will be travelling more or less towards the offtake and nearly at right angles to the vane at that point. This will result in formation of cover eddies and silt from behind the vane will be sucked out and drawn into the offtake. Therefore, the point of the longest vane nearest to the upstream edge of the offtake shall be far removed from the offtake so as not to come within the influence of too strong a draw.

3.7 Width of Canal to be Covered by Vanes—The width of parent canal to be covered by vanes is given in Table 1.

3.7.1 Minimum number of silt vanes used shall be 2.

3.8 Height, Thickness and Spacing of Vanes—The height of vanes may be one-fourth to one-third of the depth of flow in the parent canal for strong effects but for ordinary cases less height is generally sufficient and more height is very rarely necessary. A sectional elevation of vanes showing the height and spacing is given in Fig. 3.

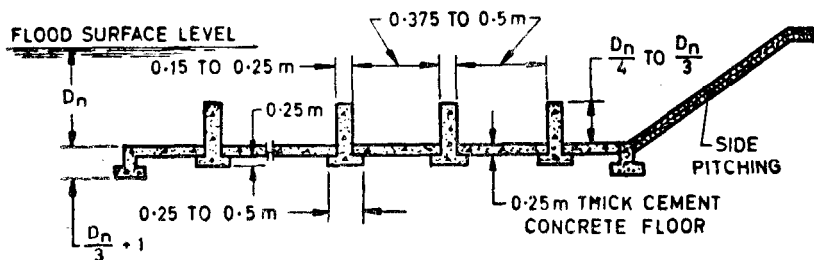


FIG. 3 SECTIONAL ELEVATION OF VANES

3.8.1 The thickness of vanes should be kept as small as possible according to their height as thinner vanes are more efficient. Faces of vanes should be smooth and even.

3.8.2 The width of canal between vanes should ordinarily be about 1.5 times the height of vanes. It may be considerably more, if very strong effect is not desired. If it is proposed to construct only a few vanes, that is, fewer than indicated by the criterion given, it would be better to place them farther apart so as to cover a greater width of the parent canal up to half the width of the offtake.

4. BED AND SIDE LINING

4.1 The length of the parent canal, covered by vanes and for a distance of 10 times the depth of flow (D_n), or 15 m, whichever is less, upstream of the vanes shall be suitably lined. This will cause suspended silt to drop as low as possible in the water by the time it reaches the vanes where it is diverted.

5. REVERSE VANES

5.1 Where the parent canal is small and silt vanes occupy most of its bed width, the heavy silt is deflected towards the edge of the canal and as the velocity there is low, it deposits there. It is sometimes advisable to construct a set of reverse vanes as shown in Fig. 4.

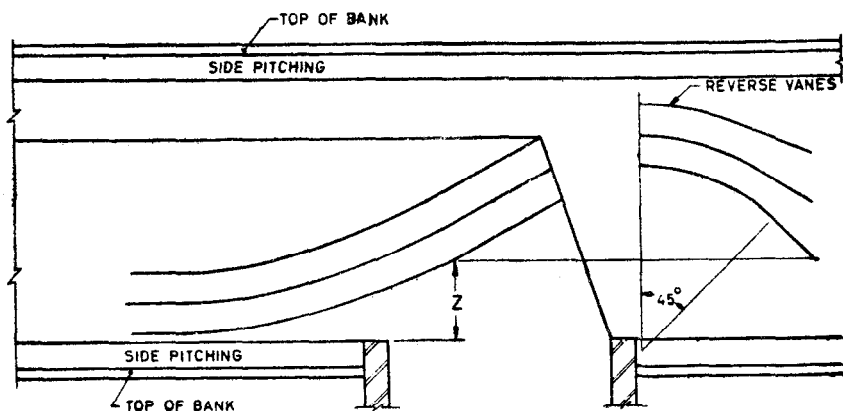


FIG. 4 SILT VANES WITH REVERSE VANES

5.2 The curved portion of vane nearest to the offtake should subtend an angle of 45° at its centre. Curves of reverse vanes need not be concentric. Upstream ends of these vanes shall be at a slope of 1 in 3 with cut water noses. The distance of the nearest point of the reverse vane from the downstream edge of the offtake shall not be less than Z for silt vanes.

6. LIMITATIONS

6.1 Silt vanes shall not be provided when:

- a) discharge of offtaking canals is more than one-third of parent canal (*see* Note);
- b) a small offtaking canal is situated between two large branches and has its bed at high level; and
- c) in canals, where there is no fixed discharge and there is fairly large surging due to fluctuations in supplies.

NOTE — If it is proposed to use silt vanes in case of high discharge, care should be taken to see that there is sufficient water passing over vanes to fill the offtaking canal without creating eddies.

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